ENGINEERING NEWS

Tribune Building, New York City.

GEO. H. FROST, PROPRIETOR.

SATURDAY, JULY 30, 1881.

WILLIAM MILNOR ROBERTS, CIVIL ENGINEER.

On the 14th current, at Rio de Janeiro in Brazil died COL. W. MILNOR ROBERTS, CIVIL ENGINEER, aged seventy-one years, five months. For upward of three-fourths of that lifetime he was busy in his calling, always in the front rank of it. Most of us will assent that he fell in its van. Only in one or two of his great and able contemporaries shall we find, as were met in him, at once the bright faculty, the impetuous energy, the long career and the varied experience covering every department and detail of his profession. Together with this bounty of Heaven in mind and in opportunity, went a corresponding moral endowment—honor, faith, decision, firmness—the god within him called Integrity of Character, which is the glory of man. And with all fullness of spirit, who that knew him but must remember the shapely, vigorous frame he had, the manly front, the sparkling dark eye, the beaming smile! For never a kindlier heart beat in human bosom.

Contemplation of gifts and achievements so diversified is in some ways discouraging. Like discouragement attends the stories of most eminent men. We incline to reason that the achievements follow largely from the gifts. Here and there an outstanding tree, happy in station and climate, comes to full growth, while its brethren of the forest spindle up to what daylight they can get and what development their conditions permit. Now and then, also, an exceptional man, happy in birth, breeding and circumstance, seems to fill in all its corners the mold of possible attainment, while his fellows of the same ore run snub, and chill, and thick, for lack of original fire. And instead of emulating him as the biographers urge us, we rather lose heart and are apt to solace ourselves in the conclusion that 'tis all as God wills, it needs little fish to show the big one big; the ant may work its life out but it cannot make honey, and the like. The tendency, in short, is, and such writers as Carlyle do evil by aggravating the tendency, to set apart the great workers of the world by themselves, as a privileged class specially ordained to greatness, whom it were folly, if not impiety, to make our examples. This is a servile error, ending in shrunken spirit and the lethargy of cowards. It is embezzlement, moreover, of our fellowly ownership in the great, making the worth of the worthiest to lie in success, so-called, or material achievement which is in truth but incidental, the true achievement being character through faithful labor, attainable by all.

For neither have these, our brethren, nor especially has this our brother, however rich the endowment to begin with, wrought to any fruitful result without laborious effort. Bright and strong as he was made, he did not build roads, frame bridges, improve natural rivers and make artificial ones by what certain notional moderns call automatic cerebration. It cost him brave bodily toil, courageous persistence, studious thought, tedious inquest, wearisome plodding of mind and hand, wherein the humblest of us may emulate him with good hope and a sure guerdon. It cost him, too, what may go to hearten us further and what, in the topping sparkle of his record, we are apt to forget, namely, the frets, worries and contentions from which no mortal man hath privilege, Like the noble Aurelius before him, whom Empire itself failed to exempt, he too began many a morning with "the busybody, the ungrateful, the arrogant, deceitful, envious, unsocial" He knew, as we have known, the vain, carnstairie President, the self-seeking Director, the pompous Selectman, the rascal Lawyer, the litigious Contractor with his maddening extras, the Deacon furious over the destruction of a fence rail, the Agriculturalist blaspheming at the track through his rye, all the haunting devils of the Engineer; and he learned in that school of many teachers the benign forbearance, self-control and patience which we also may learn in our struggle through the same curriculum.

From these various exercises in the field, the office and the world, he came, let us remember, not only with the prizes which the greater number of us must needs fails of, but, best and preciousest of all, with that god of a perfect integrity and spotless moral beauty in him which is within the endeavor of the least of us. By what we love and admire him most for, we likewise may become lovely and admirable.

To leave generals: The present writer had the happiness to serve both as rodman and topographer in his earlier years under Mr. Roberts, and subsequently as his principal assistant in charge of a field corps. Never was there, or could there be in this world, a more delightful chief; so genial, so affable, so full of humor, so buoyant in spirit, so enthusiastic in work and exuberant in play. Our field was in Western Pennsylvania, a region of high hills and tucked-in valleys, covered mainly with the original forest. He got him a pony, and, like all the old breed of engineers grown in that Commonwealth—God bless her!—kept in advance of us, exploring the ground in detail. Every day or two came a letter by special hand, telling me how best to approach a summit, what side of a valley seemed most auspicious, what make of ground and what surface cumber to expect. A complete itinerary, in short, or rather in long; he was master of his native tongue and fond of wielding it, and, mixed in with the professional instructions, numberless sparkles of pleasantry, the gushing overflow of his joyous nature and hilarious good will, tricksy turns of speech, benevolent raillery—even puns, laughable, extravagant puns themselves, for which, I have observed, all those magnificent oldsters had a certain weakness. Macdonald succeeded me in that pleasing companionship. I rode and tied with Mr. Roberts about forty miles across country on my departure for a separate charge. You may well believe I managed to do most of the tying for my revered comrade on those winter hills. We lodged the first night at a wretched tavern, in a little box of a room, with only the scratch coat of plaster on, damp and frosty. While we stood quaking in our shirt-tails I remember asking Mr. Roberts which side of the bed he preferred, as I could sleep on either. "Well!" said he, "I generally take the top side; you can have the other!" with that winning glance and laugh. Next day we parted company, and I saw him only at long intervals, for "how d'ye do," until within a few days of his embarkation for Brazil. Hearing of his proposed exile, and happening to say that I would like to see my old chief, before he went, to some one who told him of it, instead of waiting the call he came himself, quite abashing me with such condescension at a time when other demands kept him so busy. Another half hour of the same gladsome face as of old, the same cheery voice and gracious good fellowship, which seemed to lift you half way up to him, and he was gone.

Gone now he is forever. The clods of the valley are over him. Of all his early associates in his native State, Colonel James Worrall, of Harrisburg, is, I believe, the sole survivor, brought up in one school, and in many respects the like frame and temper of large manhood. "Like in difference," as the poet says; the same music set to other noble words. Heavy must his heart be over these tidings from the south.

Fathers both: Peace to the dead; peace and honor and happy the years that remain to the living.

WM. F. SHUNK.

PERSONAL.

W. B. Palmer, C. E. (late with B. H. Hull, Civil and Hydraulic Engineer of Bridgeport, Ct.), has accepted the position of Division Engineer on the Lehigh & Hudson River Railroad near Hacketstown, N. J. Forty miles of this road is now under construction.

Mr. E. L. Corthell has been appointed Chief Assistant Engineer of the New York, West Shore & Buffalo Railroad Company. The headquarters of the company are in this city.

A dispatch from Akron, O., dated July 21 states: "Mr. J. E. Abbott, Chief Engineer and projector of the Continental Railroad, who has been lying at the Empire House seriously ill for the past week, died about eight o'clock last night. Mr. Abbott has had several cases of sunstroke during the extreme hot weather, which brought on brain fever and finally led to death. His wife and son-in-law, Mr. Maurice Helling, of Brooklyn, N. Y., arrived here Sunday. They departed with the remains today for New York, Mr. Abbott's home. Mr. Abbott was one of the projectors of the Continental road, and it loses a valuable man by his death. He made many friends in this city during his short stay here, while the line of the road was being run through Akron."

NEW YORK AND BROOKLYN BRIDGE.

(*Continued from page 292.*)

"Work on the New York anchorage began about May 1, 1875, and the first stone was set Aug. 5. Work was closed Dec. 11, 15,067 cubic yards of masonry having been laid during the season, at an approximate cost of $14.50 per yard, of which $9.50 were for stone. Work began again April 10, 1876, and the masonry was completed ready for cable making Aug. 31. * * *

"The increased cost in New York for labor, etc., is due to the greater delays in handling material and to pressing the works, two gangs of masons being employed during the day and one at night, instead of one day gang.

"Approximate estimates of the cost of the Brooklyn tower, as it stands, show that the masonry for labor and contingencies (or everything but materials used in masonry), cost per cubic yard, $7.84. This includes labor, foremen, machinists, watchmen, scaffolding, wear and tear, rent of stone yard, towing scows, coal, etc., and may be subdivided as follows:

Top of caisson to high tide, per cubic yard	$4.10
High tide to roadway, about " "	6.20
Roadway to springing " "	9.10
Springing to top " "	12.60

"Of this, the cost of the stone from the time it was laid alongside the dock, at Red Hook, until it was laid alongside at the pier averaged $1.10 per yard. If we deduct this from the cost of each portion as previously given, we get the relative costs (independent of the cost of stone) of the various portions about as the following numbers:

Below tide	13
Tide to roadway	18
Roadway to springing	29
Springing to top	39

"In other words, the first 80 ft. above the roadway cost about one and one-half times as much per yard for labor and contingencies as the 120 ft. from high tide to roadway, and the 72 ft. above springing about twice as much.

"The average cost of the stone used in the Brooklyn tower, delivered at Red Hook, was about $21 per cubic yard, varying all the way from $15 to $88 per cubic yard.

"Excavation in the Brooklyn caisson cost for labor only, including the men on top, about $5.25 per cubic yard. Running the six air compressor s

added to this $3.60 per hour, or about 47 cents per yard; lights added 56 cents more; and these, with other contingencies, nearly equaled the cost of labor. The great cost was due to the excessive hardness of the material over much of the surface, the caisson finally resting over nearly its whole extent on a mass of boulders or hard pan.

"The concrete in the caisson cost about $15.50 per cubic yard for every expense. The caisson and filling together aggregated 16,898 cubic yards, and the approximate cost per yard for every expense was $20.71. This was less than the cost of masonry laid in the open air.

"The labor of making these estimates is very great; and it has not been done for the New York tower.

SETTLEMENT OF MASONRY.

"Bringing the account of the work up to the latest date,* it is sufficient to say, in closing, that the settlement of the Brooklyn tower, at the time of completing the masonry (measured from marks at all salient angles, which were made immediately after the work reached high water), averaged 0.101 ft., the extremes being 0.08 and 0.102 ft. The average for the New York tower was one and one-eighth inches, with a still closer correspondence, but the figures are not at hand.

"The settlement of the New York anchorage from the time of reaching 22 ft. above tide, when the levels of all salient angles were referred to a permanent bench mark, was three-quarters of an inch across the front, and one and three-quarter inches across the rear. The difference is, no doubt, due to the greater proportional weight at the rear. The figures for the Brooklyn anchorage are about the same, but are not at hand."

(TO BE CONTINUED.)

NEW CAISSON-COFFER-DAM FOR LOW FOUNDATIONS.

Translated for Engineering News from Annales des Ponts, etc.]

The use of compressed air for laying the foundations of bridges has been greatly generalized of late years. Formerly it was only employed where water which ought to exist between the level of the low-water mark and the bottom of the fitting in, if we make use of the usual system of foundations. Let us also remark that the caisson is lost, that the irons remain in the mason work, and that the expense under this head has a great influence on the cost in the case of foundations at low depths, representing only a small cubic extent of masonry. It may be said that the advantages of compressed air vary as the depth, while the objection and the cost vary in inverse ratio to this depth. There must be, therefore, a limit beyond which there is an advantage in using compressed air, and below which the open air system should be preferred. This limit appears to be between four and five meters.

For greater depths than five meters it is more advantageous to use compressed air, and for those below four meters to build in the open air. There are cases, however, in which this general rule cannot be followed, as, for instance, when bridges have to be built in one season over rivers subject to freshets which would disturb the foundations if built in the open air. It is preferable, in this case, to make a sacrifice and use compressed air. M. Liebaux had to build several bridges over the Dordogne in such conditions. He made use of a caisson-coffer-dam, which was both durable and movable, and the results obtained lead him to believe that the system is a solution of the question of employing compressed air for foundations at low depths.

This mixed system combines in fact all the advantages of compressed air, without any of the objections which are urged against it. All the difficult part of the work is done by compressed air—the taking away the silt and the fitting in. The mason work is then built up in the open air, and

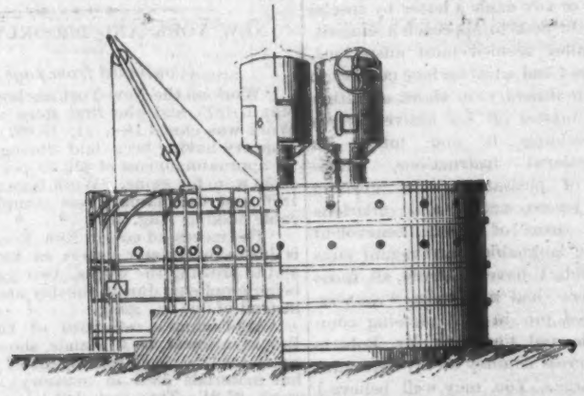


FIG. 1.—HALF LONGITUDINAL SECTION AND ELEVATION.

the depth of the foundation had at least nine meters, afterwards it was used for depths of six, five, four and even 3.40 m.

The system possesses, in fact, the great advantage of allowing work to be carried on in all seasons; the cost too has been considerably reduced by competition, and there will be a further reduction, until it is about the same as for work in the open air.

Unfortunately, however, the use of compressed air for foundations at small depth presents some serious drawbacks. It is difficult to superintend the work when the work-chamber is filled with beton, and to put the caissons in place, because the work-chamber itself takes up the masonry of the foundation. There should be a sufficient depth of water so that the caisson and masonry executed during the sinking should be below the level of low-water mark. The caisson is always at least two meters in height and the masonry one meter, which gives at least three meters as the height of finally, when the pile is out of the water, the whole caisson is taken out without leaving a single piece of iron in the masonry.

The putting in place is easy, and there is no difficulty in superintending the work. There is no minimum limit with this caisson, which offers a superior method of employing compressed air, and secures a rapidity and certainty of work which are offered by no other.

The apparatus, invented in 1879 by M. Montagnier, consists of a bell, five meters in height, in which the air is compressed, and under which the work of removing silt, the fitting in and the construction of the pile (Fig. 1 and 2) is carried on.

The caisson has the shape of the pile to be built, but it is larger in every respect, and this facilitates the putting in place. It is composed of vertical pieces of sheet iron of two meters in width, consolidated by horizontal T-irons, and small vertical beams. The pieces are banded together by T-irons and bolts. Strips of india rubber of 10 millimeters insure the absolute airtightness of each joint. The caisson is covered with a roof which is made very resisting by a series of beams of about 0.60 m. in height. The roof is joined with the caisson in the same way as the segments are with each other, and is supported inside by a series of braces, which are joined to the small vertical beams of the caisson. Interior frames made of T-irons complete and insure the rigidity of the whole apparatus. Finally three sluices, of which two are circular, and the third elliptic, give access to the caisson.

A scaffolding supported by two boats joined together are used for putting the caisson in place, the caisson being raised in the middle of the scaffolding by screw jacks of a power of 10,000 kilos. Knowing the weight of the caisson, of the scaffolding, and of the accessories, and the surface of the boats, we can determine beforehand what will

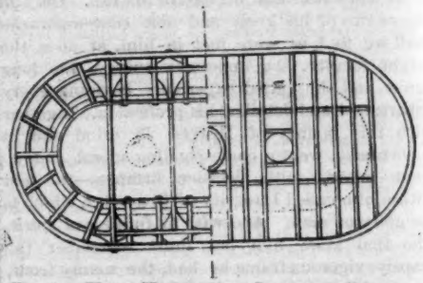


FIG. 2.—HALF HORIZONTAL PLAN AND SECTION.

be the sinkage of the latter. In order to resist the sub-pressure of the compressed air, the caisson is heavily ballasted with pig-iron placed on the roof between the beams, and the load is increased in case of a freshet. The caisson which was used in building the piles for the bridge at Garrett was thus loaded with a weight of 130 tons, and could have borne a much heavier load.

The manner of operating is as follows: The caisson being put in place and ballasted, the fitting in of the pile and the masonry of the first layer was rapidly proceeded with. Quoins of hard wood were continuously intercalated between the caisson and the rock, and the caisson put in communication with the open air so as to continue the building. Contrary to expectation, the weight of the caisson was not sufficient to insure the staunchness of the method of jointure, of which mention has been made, and a slight layer of beton had to be put all round to the depth of 0.10 to 0.15 centim. This done, the caisson was pumped out by the same machine, and 10 or 15 minutes work per hour was enough to keep it dry. When open air work was required the two ends of the roof were taken down, the sluices and the rest of the roof were left standing. A few nuts had only to be unscrewed and this work was done in half an hour.

The piles made by this system cubed respectively 58.32 m. and 73.48 m. The average cost of the cubic meter came to 318 fr. This high cost was caused by the small depth of the foundation (1.95 m. and 2 meters), which might have been far greater without much more cost.

Besides this a new engine had to be built.

THE HISTORY AND STATISTICS OF AMERICAN WATER-WORKS.*

BY J. JAMES R. CROES, M. AM. SOC. C. E.

(*Continued from page* 295.)

XLIII.—SPRINGFIELD.

Springfield, Massachusetts, is on the east bank of the Connecticut River, in lat. 42° 6′ 10″ N., long. 72° 31′ 12″ W. The western part of the city is level, the eastern part is on high ground rising gradually from the river valley. Mill River runs on the south side of the city.

Settled in 1636 and first called Agawam, its name

* September, 1876.

* Copyright 1881.

was changed in 1640 and in 1833 it was incorporated as a city.

In 1843, the population being 11,000, Charles Stearns built a reservoir on the site of the present Lombard reservoir, and laid 3 miles of wooden logs, bored to 7, 6 and 4-in. diameter.

In 1845 the works were enlarged and the Springfield Aqueduct Company organized; they built the "Lombard," "Heywood," "Chapin" and "Worthington" reservoirs.

The number of takers at this time was 700, and the annual water rents amounted to $2,700. The company enlarged its works from time to time, but the supply was always inadequate. In 1867 the wood pipes were replaced by wrought-iron and cement, the east Van Horn reservoir was constructed, which was estimated to contain 45,000,000 gallons, and the Lombard reservoir was subsequently enlarged, and the west Van Horn reservoir built.

The first action taken by the city was in 1860, when a well 20 ft. deep and 10 ft. diameter was sunk, the flow of which was estimated to be 50 gallons per minute.

In 1860 a private company known as the City Aqueduct Company was incorporated, which, in this year, laid 1,950 ft. of 7-in. pipe and a brick drain or gathering gallery, along the base of the hill. The flow was about 40 gallons per minute. This awakened much opposition from residents on the hill, whose wells it drained, and whose trees suffered from want of moisture. The following year it was purchased by the city for $2,921.12 and abandoned.

In 1873, works were constructed by the city after the plans of Phinehas Ball, C. E., taking water from Broad and Higher brooks, whose drainage area is about 6.7 square miles, and impounding it in the Cherry Valley reservoir of 445 acres water surface at 402 ft. above the city datum plane.

The reservoir is formed by two earth dams. The Cherry Valley dam is at the outlet of a tributary of Broad Brook, and the Ludlow dam in the ravine on the divide between the drainage areas of Higher and Broad brooks.

The foundation of Cherry Valley dam begins on compact bluish hard pan. The bank was built of this material in 18 and 24-in. layers, each layer being flooded with a thin film of water, on which the next layer was dumped and driven over by teams. A heart wall of rubble masonry, 18 in. thick and 1,297 ft. long, comes to within 2 ft. of the surface of the bank, and is protected from frost near the surface by a dry rubble wall on each side of it, 2 ft. in depth from the top and 18 in. thick.

The dam is 25 ft. wide on top with slopes of 2 to 1, 39 ft. high above the natural surface and 47.6 ft. high above the lowest point of excavation, 2,352 ft. long, 1,521 ft. of which ranges from 3 to 5 ft. in height. The waste pipe is 20 in. in diameter laid, in stone masonry, and has a gate at each end. The inside slope is covered with rubble paving, 12 to 29 in. in thickness, the interstices filled with blue clay. The over-fall masonry rests on ledge rock and is 34 ft. long.

The Ludlow dam is 496 ft. long with a heart wall of rubble masonry 3.33 ft. wide with 6-in. concrete core. It is 35 ft. wide on top, 18 ft. high above the natural surface and 22 ft. high above the foundation.

A masonry gate-house is built in the dam from which a 30-in. cast-iron pipe is laid. A short distance above the Ludlow dam a dry rubble wall was built for holding in place a quantity of sand and an open space 100 ft. in length for filter screens. The space between the dam and the filter is four acres in extent, and was covered with clean sand. The filtering materials are placed in a duplicate set of vertical movable boxes made of oak plank. The filtering material is wood "Excelsior," and acts only as a mechanical filter. The thickness of material is 28 in. or 14 in. in each box. A derrick on a bridge over the filter raises and lowers these boxes into place. This filtering apparatus appears to have been used in 1875, but no mention of it is made in later reports.

The reservoir is centrally situated between the Higher and Broad Brook water sheds, and the water from these streams is conducted to it by canals. The canal to Higher Brook is 5,278 ft. long and has a grade of 3.7 ft. to the mile. The Broad Brook canal is 11,960 ft. long and has a fall of 1 ft. in this distance. It is 8 ft. wide at bottom and 6 ft. deep, with slopes of 1½ to 1.

In 1877 a waste channel of masonry fitted with iron gates was built through the Cherry Valley dam at the south end, through the over-fall and the bottom of the inner slope of the dam was covered with additional embankment.

The inner slope of the Ludlow dam was covered with loam, with the object of silting up all crevices in the gravel and preventing a leakage which had appeared below the dam and caused some uneasiness. Three overflows were constructed in the Broad Brook canal.

The main conduit to the city is 24 in. in diameter, 56,410.5 ft. long, 3,736 ft. of which, from Ludlow dam to Higher Brook, is of cast iron. The Chicopee River is crossed at Indian Leap by a bridge of 168-ft. span, the upper chords of which are two tubes 26 in. in diameter, 12 ft. apart which form the aqueduct. They are made of ⅜ in. boiler plate, riveted, and were lined with cement after erection. This bridge was designed and built by John R. Smith, C. E.

The rest of the conduit pipe is of wrought iron, lined and covered with cement laid on by hand after the pipe was in the trench. On being first filled many leaks occurred in a section of this pipe about 2,000 ft. long, where the ground was very firm and of good gravel. They were attributed to the fact that this part of the pipe was laid in very hot weather, and the cement at the joints set too quickly.

The section of cast-iron pipe gave great trouble from its having been laid in quicksand and settling. It was raised and laid on timbered foundation without interrupting the flow of water. This work of repairing was continued for four years.

There are two distinct services. The high service is supplied directly from the Cherry Valley reservoir, and the low service is supplied from the high by a regulator valve, and also through the Van Horn and Lombard reservoirs. The upper Van Horn reservoir has an area of 9.5 acres, a depth of 24 ft. and a capacity of 28 million gallons. The lower Van Horn reservoir has an area of 13.5 acres, is 30 ft. deep and contains 73.6 million gallons. The Lombard street reservoir has an area of 3 acres, is 23 ft. deep and contains 9 million gallons. All have their water surface at 198.5 ft. above the city datum.

The distribution pipes are partly of cast iron and partly of wrought iron and cement; 63.93 miles are in use, from 2 to 24 in. in diameter, 19 miles of which are of less than 6 in.

In December, 1880, there were in use 381 fire hydrants, 25 fire reservoirs, 3,290 taps and 44 meters. The use of meters began in 1878.

The population in 1870 was 26,703, in 1880 it was 33,340.

The daily consumption is not given in the reports. The cost to December 1, 1880, was $1,216,847.53. In 1880 the cost of maintenance, exclusive of interest and construction, was $10,008.31, and the revenue $79,280.92.

The works are under the control of a Board of three Water Commissioners. Phinehas Ball C. E. designed the works, and they were carried out under his superintendence and that of Geo. A. Ellis, C. E., City Engineer, who is engineer and registrar of the works at the present time. J. C. Hancock is the superintendent.

XLIV.—SALEM.

Salem, Massachusetts, in lat. 42° 34′ N, long. 70° 54′ W, is chiefly on a low tongue of land, formed by two small inlets of the sea. Settled in 1626, its population in 1796 was about 8,000, when Daniel Frye dug a well on Gallows Hill and supplied water from it to several consumers through wooden pipes.

In 1807 an association of five members, styled "The Proprietors of the Frye Aqueduct," was formed, taking water from this well. In 1809 there were 12 takers, and in 1852 the company expired.

A second company was organized in December, 1796, which was the beginning of the "Salem Aqueduct." Their first works consisted of a fish hogshead sunk in a spring on Gallows Hill, and wooden pipe of 3-in. bore. In 1798 they built a reservoir on Gallows Hill 10 ft. deep and 24 ft. square.

The works were extended from time to time, but each extension was followed by complaints of scarcity of water. In 1834 a line of 6-in. iron pipe was laid down.

In 1850 16,165 ft. of 12-in. iron pipe were laid to "Spring Pond" and a reservoir built of 652,000 gallons capacity. The company after this replaced their wooden pipe with iron. In 1859 they had laid 40 miles of pipe. In 1865 a connection was made with Brown's Pond.

The complaints against this company were frequent. At times the water was entirely shut off from the manufactories. The stock always paid large dividends, but little money was expended from the earnings for improvements.

In 1865-69 works were built by the city after the plans of James Slade, C. E. Water is taken from Wenham Lake, which has a water shed of 2.7 square miles, an area of 320 acres and an extreme depth of 53 feet. It is fed by springs from the bottom and has no entering streams. The bottom is free from mud and vegetation and is of clean quartzose sand. It is surrounded by a smooth, gravelly margin. The supply is taken from the south end, where the shore is bold and the water deep.

A 36-in. cast-iron pipe, with a bell mouth turned up and grated, beginning 32 ft. from the shore, conducts the water 175 ft. to a masonry gate chamber 10×8 ft., from which a brick conduit 10×7 ft. and 26 ft. long, leads to the pump well, which is 31.75×10 ft. inside, built of stone masonry, lined with 12 in. of brick, and resting on a timber and plank platform covered with 2 ft. of concrete. Quicksand was encountered in the excavation. A Worthington compound engine of 5 million gallons capacity lifts the water 114 ft., through 5,600 ft. of 30-in. cast-iron pipe, to the reservoir on Chipman's Hill, which is built in excavation and embankment, is 400 ft. square and 20 ft. deep, and contains 20 million gallons, with its surface 142 ft. above mean tide. A puddle wall is built in the centre of the bank, stepped down the slopes and carried 2 ft. thick over the bottom, where it is covered with 1 ft. of gravel and a stone paving. The inner slopes are covered with 12 in. of gravel, on which is a dry stone wall 15 in. thick.

At the centre of the westerly bank is the influent, and in each of the southerly corners is an effluent pipe 20 in. in diameter and 2 ft. above the bottom. They are surrounded with screen cribs containing screens 8 ft. high. The tops of the cribs are solid and have a trap door for access to the pipe. The pipes pass through the bank turning downward and then following the clay puddle. Each pipe is supported on a brick pier. Two walls of masonry 2 ft. thick are laid across the be-

ginning of each pipe to prevent the water from following it. Under each is a drain pipe of 10-in. diameter.

The force main is connected with the supply mains, and at their junction is a 30-in. wrought-iron stand-pipe 55 ft. high, extending 25 ft. above the water surface of the reservoir.

The supply main is a 20-in. cast-iron pipe, and is carried across Bass River, the arm of the sea between Beverly and Salem, in a wooden box on piles, passing under the channel by an inverted siphon of 30-in. pipe, boxed with heavy timbers and filled around with concrete.

Water is supplied to the town of Beverly by special contract.

The distribution is by wrought-iron and cement pipe, of which 85 miles were in use in 1879. In that year there were in use 343 hydrants and 117 meters. The number of taps is not given. The consumption in 1879 was 1,940,000 gallons per day.

The population of Salem in 1880 was 27,598.

The total cost of construction to November, 1879 was $1,338,155.48.

In 1879 the revenue was $50,629.74.

The works were built by a board of Water Commissioners, and have been managed by the Wenham Water Board.

James Slade was chief engineer until 1868. James P. Kirkwood was consulting engineer during construction, after February, 1868, and Charles H. Swan the chief engineer. James W. Lyon is the Superintendent.

XLV.—NEWPORT.

Newport, Kentucky, is on the south side of the Ohio River, opposite Cincinnati, and separated from Covington by the Licking River on the west.

The site of the town was first occupied in 1791. The population in 1871 was 16,000, when water-works were built by the city, after the plans and under the superintendence of Theodore R. Scowden, C. E., taking water from the Ohio River, 4 miles above the city.

The engine-house is on limestone rock at the river's edge. Through an arched opening in the wall the water is admitted to the pump-well, the floor of which is 3 ft. below extreme low-water mark.

The water is lifted 350 ft. through a 20-in. cast-iron main, 1,445 ft. long, by a direct-acting non-condensing pumping engine, with vertical steam cylinder of 26 in. diameter and 48 in. stroke, 57 ft. above a double acting plunger pump of 18⅛ in. bore. The connection between the pump and the main is by an 8-in. pipe.

At the crest of the bluff, the force main discharges into a cast-iron main of 24 in. diameter for 275 ft., and of 20 in. diameter for 4,318 ft., in which distance it falls 56 ft., discharging into the reservoir formed by an embankment across the junction of the two ravines, and divided into two basins by a transverse embankment. The main dam is 35 ft. high, built of earth, with stone paving on the slope. The water surface is 8 acres and the capacity 41 million gallons. The surface drainage from the surrounding country is carried under the reservoir in 24-in. iron pipes, meeting in a 36-in. pipe, which passes under the dam, with stone collars 8 ft. square and 2 ft. thick every 12 ft.

Two 30-in. effluent pipes, laid through the dam, conduct the water to the 20-in. supply main in the city.

On June 17, 1875, one of the 24-in. drain pipes broke, the north basin was rapidly emptied and the slopes slid in. On examination, it was found that half the drain pipes were broken. They were stopped up, surface drains made, and the banks reconstructed. The slopes of the south basin showed a tendency to slip in 1878, and not more than 12 ft. of water could be safely put in it, and in 1879 one oot less was stored. In 1880 there were indications of saturation of the earth past the centre of the main bank.

The distribution is by cast-iron pipe. In Dec., 1880, there were 20.45 miles in use, nearly half of which is of 4-in. diameter. There were 110 fire hydrants, 1,577 taps and 16 meters in use at that date. The consumption is not given, but the engine is reported as working to its full capacity nearly all the time. The population in 1880 was 20,433.

The cost of construction, including repairs to 1881, had been $780,781.11, and the revenue from water rents $91,356.61. The bonded indebtedness is $700,000. The total receipts for the year 1880 were $21,861.39, and the expenditures $13,238.39.

The works are controlled by a board of three trustees, who report to the Common Council. George Hornung was the Engineer and Superintendent from 1873 to 1877. From 1878 to 1881 B. R. Morton has been City Engineer and Superintendent of the Water-works.

XLVI.—NORWICH.

Norwich, Connecticut, in lat. 41° 32′ N., long. 72° 5′ 28″ W., is 15 miles from Long Island Sound, at the confluence of three small streams which form the Thames River, and which, having a rapid descent, afford a valuable water power.

The population, which in 1810 was 3,528, had increased to about 15,000 in 1868, when water-works were constructed by the city, after the plans and under the superintendence of John T. Fanning, C. E.

The supply is by gravity from two small streams N. E. of the city, 252 ft. above tide level and 225 ft. above the main street of the city. The impounding reservoir is formed by an earth dam 25 ft. high and 468 ft. long, 25 ft. wide on top, with rubble masonry heart wall through its centre, and its inner slope paved with stone.

The overflow waste-way is in a depression a mile from the dam, leading to another valley. The shores of the reservoir are cut down vertically to 4.5 ft. below the flow line, and protected by a vertical dry stone wall, 2.5 miles long. The area of the reservoir is 66 acres, and its tributary watershed 0.75 sq. mile. Two filtering dams have been made at the inlets of tributary streams.

From a masonry gate-house on the inner slope of the dam a 16-in. copper pipe, designed by Mr Alba F. Smith, with a flexible joint which permits the end of the pipe to be adjusted to take the water from the pond at any depth, conducts the supply to the gate chamber.

The first pipe collapsed in 1873, and was replaced by one of heavier copper.

The distribution pipes are of wrought iron and cement. They are mostly of 6-in. and 4-in. diameter. More than 9 miles are less than 6-in.

On Oct. 13, 1869, and July 27, 1873, the distribution pipes were struck by lightning. In the first case 2,000 ft. of pipe were injured and in the second 94 ft. The joints appeared to have been "struck with a ball 2 in. in diameter, leaving a dent in the form of a spoon and with the appearance of burnished silver." In March, 1880, there were in use 30 miles of pipe and 245 hydrants.

The number of taps on March 31, 1878, was 1,503. Service pipes are of wrought iron and cement.

The population in 1880 was 21,141. The consumption is not stated in the reports.

The cost of the works to March 1880 had been $411,870.94, the receipts for the previous year $34,-169.24, and the cost of maintenance, $6,262.62.

The works are managed by a Board of Water Commissioners.

The superintendent is H. B. Winship.

XLVII.—WILLIAMSPORT.

Williamsport, Pennsylvania, is in lat. 41° 14′ N., long. 76° 2′ W., on a plain between the north bank of the West Branch of the Susquehanna River and a range of hills. The town was founded about 1795, and incorporated as a city in 1861.

Lycoming Creek flows through the city from the north, and parallel to it is Loyalsock Creek, two miles east of the city limits. Two private companies supply the city with water. The Williamsport Water Company, incorporated in 1853, when the population was 2,500, procures its water from Hagerman's Run, and the Citizen's Water & Gas Company, incorporated in 1865 as the Lycoming Gas & Water Company, procures water from Mosquito Creek. Both of these are mountain streams, south of the river, each draining about 25 sq. miles, and dammed about a mile and a half from the city at 140 ft. above the river. Neither company has more than a small basin, less than a hundred feet square, for settling purposes.

The water is conveyed to the city in two 16-in. cast-iron pipes, which pass under the river for 1,000 ft. The distribution pipes are of cast iron. The two companies supply 2,500 consumers and 150 fire hydrants, for which the city pays $10 each per annum. The population in 1880 was 18,934 Meters are not used. The amount of water used, and the details of cost and revenue are not furnished. J. H. McMinn is superintendent of the Citizen's Water & Gas Company.

XLVIII.—DAYTON.

Dayton, Ohio, is on a level plain at the confluence of the Mad and Great Miami rivers. Settled in 1796, it made little progress until 1829 on the opening of the Miami Canal. It was incorporated as a city in 1841.

Water-works were built by the city in 1869–70, taking the supply from wells and from the Mad River.

The first well was sunk 300 ft. south of the Mad River and ¼ of a mile above its junction with the Miami. The well is about 20 ft. in diameter, and is sunk below the bed of Mad River. A conduit connects it with a trench 100 ft. distant, which is 108 ft. long, 18 ft. deep and 15 ft. wide. The well and trench are both roofed. The capacity of this source was about 500,000 gallons per day. In 1873, the supply falling short, connection was made directly with the Mad River by three lines of 20-in. cast-iron pipe, laid out into the river, the end supported in a revetment wall of masonry 15 ft. high and 50 ft. long. Against the wall boulders were piled to act as a strainer. Inside the levee the pipes are also supported by a masonry wall. The water from this had a brownish color and a strong odor and taste.

A second well was dug in 1875-6 30 ft. deep and 18 ft. diameter. This supplied about 500,000 gallons per day.

The supply being inadequate, and resort being constantly had to the Mad River, which is very impure and takes the drainage of a thickly populated valley, the construction of a second filter gallery was begun. In 1880, 106 ft. of it had been finished. It is a rectangular chamber, 4 ft. wide and 8 ft. high, with dry stone side walls, flat stone cover and plank flooring, 26 ft. below the surface of the ground.

The first pumping engines consisted of two Holly elliptical rotary pumps of 2,000,000 gallons capacity and a set of gang pumps of 3,000,000 gallons capacity in 24 hours. In 1880 these pumps were removed and four piston pumps on an inclined frame, geared to the old engine, 3 to 1, were substituted.

The second pumping engine erected in 1873-4 is a Holly Compound Engine, with four steam cylinders, of 18-in. diameter and 30-in. stroke. The pump cylinders are 12 in. in diameter and 30-in. stroke. The capacity of this engine is 4,000,000 gallons in 24 hours. The engines pump directly into the mains under 50 lbs. ordinary pressure and 100 lbs. fire pressure.

The distribution is by cast-iron pipe, of which in 1880 32.5 miles were laid, most of which is of 4

and 6-in. diameter. On Jan. 1, 1881, there were 286 hydrants and 1,211 taps.

The use of meters began in 1877, and in 1880 there were 18 in use.

In 1876, hydraulic elevators were introduced, and in 1880 there were 16 running.

In 1880, the population was 38,677, and the daily average consumption 1,058,737 gallons, as computed from the pump capacity.

The cost of the works to Dec. 31, 1880, was $705,917.80, and the total receipts had been $201,531.47. The expenses for 1880 were $20,483.73, and the receipts $19,644.72. The bonded indebtedness is $555,000.

The works are managed by a board of three trustees. William C. Weir, C.E., was consulting engineer during construction. George McCain was superintendent from 1870 to 1873, when the office was abolished. D. B. Wilcox performs the duties of secretary, engineer and superintendent.

XLIX.—TOLEDO.

Toledo, Ohio, is situated on both sides of the Maumee River, five miles from Maumee Bay and eight miles from Lake Erie.

Its area is 21.5 square miles—6.2 square miles on the east side and 15.3 square miles on the west side of the river.

It has an easy ascent to the table-land on which most of the houses are built. Settled in 1832, it was incorporated as a city in 1836.

In 1873–4, water-works were built by the city after the plans and under the superintendence of J. D. Cook, C. E.

Water is taken from the Maumee River, filtered and pumped into a stand-pipe for distribution.

A hexagonal timber crib is built in the river, the two longest sides parallel with the current, each 80 ft. long, and the four shorter sides 37½ ft. long.

It is formed by 2 rows of round piling driven close together. The space nearest the outside row of piles is filled with broken stone of sufficient size to be held within the piles; the remainder is filled with coarse gravel.

A wrought-iron pipe connects the crib with a conduit of brick 500 ft. long and 5 ft. in diameter, built in an open trench on land, and by means of a coffer dam in the water which leads to a filtering basin of 19,000 sq. ft., the sides of which have a slope of 1½ to 1 and are finished with a puddle wall, and paved with Medina sandstone. The bottom is covered with concrete. The filtering material, beginning at the bottom of the bed, consists of 24 in. of broken stone; 6 in. of 2-in. gravel; 6 in. of 1-in. gravel; 6 in. of ½-in. gravel; 6 in. of ¼-in. gravel; 24 in. of fine sand.

The maximum depth of water is 4 ft.

The filtered water is discharged into a clear-water reservoir, by means of gathering drains and an effluent pipe, and thence to the pump well.

It was found in 1875 that the filters silted up so rapidly as to be almost useless, and they have proved too small to supply the quantity of pure water required. Much dissatisfaction has existed as to the quality of the Maumee River water.

There are two Worthington pumping engines, each of 5,000,000 gallons capacity, pumping with 260 ft. lift into a stand-pipe, of No. 1 charcoal iron, ⅛ in. thick, 5 ft. in diameter and 234 ft. high, inclosed in an ornamental tower of masonry.

The distribution is by cast-iron pipe. On Jan. 1, 1881, there were 46.87 miles, 7.8 miles of which are less than 6-in. diameter.

The cost to Dec. 31, 1880, including interest, had been $1,145,476.02, and the receipts $152,455.32.

The receipts during 1880 were $28,919.18, and the expenses $20,777.35.

Meters were introduced in 1877, and there were in use on Jan. 1, 1881, 40, and 45 elevator indicators, 349 hydrants and 1,616 taps. The consumption in 1880 was 3,262,000 gallons per day, and the population 50,143.

The works are managed by a board of three trustees, reporting to the Common Council. J. D. Cook, C.E., was engineer and superintendent from 1873 to 1879. Carl Schonn was then appointed superintendent, and is the present incumbent.

L.—SANDUSKY.

Sandusky, Ohio, is on the south shore of Sandusky bay, an inlet of Lake Erie, on ground rising gradually from the bay.

The city is underlaid with limestone rock, which in many places comes to the surface.

In 1875 works were constructed by the city, after the plans and under the superintendence of J. D. Cook, C. E. Water is taken from a cove in the bay, between the city and Cedar Point. The cove is completely landlocked, except on the north, and is entirely free from the impurities issuing from the Sandusky River. Water is taken to the pump-well through a crib and conduit, and pumped into a stand-pipe for distribution.

The bay crib is composed of double rows of timber walls 8 ft. apart, the space between being filled with broken sandstone, through which the water passes before reaching the pipe. The crib is octagonal, its inner diameter is 25 ft. and outer diameter 45 ft. It extends from rock bottom to six feet above ordinary water level.

From the crib an influent pipe, 1,800 ft. long, leads to the pump well. The first 1,387 ft. is of wrought iron, 36 in. in diameter. It was laid in a trench prepared by dredging and submarine blasting. The pipe is in 90 ft. lengths, and was floated and lowered to place by scows and chains.

A half sleeve was riveted on the ends of each section, with flanges for bolts, with which the final connections were made. The joints were then cemented.

The crib end of the influent pipe has a vertical elbow, at the upper end of which is a perforated copper plate screen.

The shore end of influent pipe, 413 ft. long, is a brick conduit 36 in. in diameter.

The pump-well is a rectangle excavated in solid rock. It is 8 by 22 ft., and 21½ ft. deep below the engine-house floor. It has a lining wall of brick.

There are two Worthington engines. The compound duplex engine has a capacity of 3,000,000 gallons in 24 hours, with a lift of 220 ft. The high-pressure cylinders are 25 in. in diameter; the low-pressure 43.3 in. in diameter. The pump plunger is 17½ in. in diameter, and the stroke of all 36 in.

The non-condensing duplex engine has a capacity of 2,000,000 gallons in 24 hours, raised 220 ft. The cylinders are 24 in. in diameter. The pump plunger is 16 in. in diameter, and the stroke of all 26 in.

Water is pumped into a double stand-pipe. It consists of two concentric pipes, the intention being to have a large fire reserve, and prevent sudden strains on the pumps from the loss of head caused by the opening of a large number of fire hydrants. The pipes are built of steel plates. The outer pipe is 25 ft. in diameter and 180 ft. high, and has a storage capacity above 100 ft. of 276,200 gallons.

The bottom course of the reservoir is leaded into cast-iron shoes, constructed in segments, and with flanges and bolts, and forming when in place a perfect circle. It rests in a groove, cut in the solid rock. The pipe is further secured by 12 iron rods, 1½ in. diameter, passing 8 ft. into the rock, and secured by lead and wedges, the upper ends being riveted to the second course in the reservoir. Within the large pipe is a pipe 3 ft. in diameter and 229 ft. high, to be used for fire pressure in ordinary cases. An iron staircase on the lake side of the pipe leads to the top, which is finished with an ornamental cornice of iron.

On Oct. 20, 1878, the inner pipe burst 100 ft. below the top. It fell against the top of the large tank, breaking it, and bruising and injuring a section 25 ft. long. The damaged parts, which were ⅜ in. thick, were replaced with ¼-in. iron. After repairs, the pipe was ¼ in. for 140 ft., ⅜ for 60 ft. and ⅛ in. for 29 ft.

In Feb., 1880, the water in the pump-well became very low, and the flow gradually diminished until Feb. 13, when it entirely ceased.

During the night of the 13th the difficulty seemed to cease and the flow was as usual, but very turbid and impure. It was found that there was a break in the effluent pipe, and that the copper strainer on the end of the influent pipe had become completely enveloped with a fibrous sediment of fungus growth, impervious to water.

This growth was very tough, and when dried was non-combustible, and resembled moss.

The exhausted pipe rose from its anchorage and separated at a joint near the coffer dam.

The pipe was repaired.

The distribution is by cast-iron pipe. In Dec., 1880, there were 20.4 miles laid, 1 mile of which is less than 6 in. diameter. One hundred and forty-six hydrants and 969 taps were in use at that time.

In 1880 the population was 15,838, and the daily consumption 1,290,000 gallons.

Meters are not mentioned in the reports as being used.

The cost of construction to Jan. 1, 1881, had been $385,905.50.

The total expenditures to that date had been, exclusive of interest, $444,064.18, and the receipts $72,945.87.

The expenditures for 1880 were $12,621.53 and the receipts $13,020.01.

The works are managed by a board of three trustees. E. Graves has been the superintendent since the construction of the works.

[TO BE CONTINUED.]

Received from J. G. Briggs, Supt. W. W., Pere Haute, Ind., Description of the Water-works of Pere Haute, Ind., and Paris, Ill. From Frank E. Hall, Water Commissioner, Worcester, Mass., Annual Reports of the Committee on Water, the City Engineer, the Water Registrar, and the Water Commissioner, for the years 1877, '78, '79 and '80; also report of the committee on additional supply, June, 1881. From H. B. Winship, Supt. W. W., Norwich, Conn., Report of the Supt. of Water-works for the years 1877–78, '78–79, '79–80.

RUNNING PARALLELS OF LATITUDE.

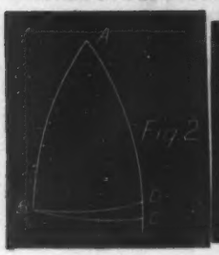
BY I. O. BAKER, PROFESSOR OF CIVIL ENGINEERING, ILLINOIS INDUSTRIAL UNIVERSITY.

[A correspondent in the NEWS of June 11 asked for information in reference to the above subject. Below is an article written for a different purpose that may give him the information desired.]

Parallels of latitude are small circles perpendicular to the axis of the earth, and consequently cross all meridians at right angles. Since all engineering instruments are mounted on vertical and horizontal axes, the line of sight will always lie in the plane of a great circle passing through the observer; and any instrumental line perpendicular to the meridian will converge on the equator. Therefore, to locate a parallel of latitude some correction or auxiliary measurement is necessary to determine the parallel with reference to the great circle run.

This is a very important subject; but it does not receive the attention of engineers and authors of engineering books, that its importance demands. It is of frequent application in land surveying and is sometimes used in railroad surveying. Three methods are available for running parallels; first, by compass—either solar or magnetic; second, by change of azimuth, and third, by offsets.

1. *By the Compass.* This method depends upon the ability to determine the direction, at least approximately, of the true meridian at each setting of the instrument. All lines run at any angle from the meridian, by courses taken at short intervals, as in ordinary compass surveying, partake more or less, according to the angle with the



meridian, of the curvature of the parallels of latitude. Since in ordinary compass work the sights are always short a line run, with the magnetic compass at 90° with the meridians, approximates as closely to a parallel of latitude as the accuracy of the instrument is capable of doing. This is on the assumption that the direction of the line at each setting is obtained by reading the needle and not by taking back-sights. When the line is prolonged by back-sights, the parallel is to be run by the second or third method, as will be hereafter explained.

Solar Compass. The following is essentially the method given by Burt, the inventor of the solar compass, in his "Key to the Solar Compass," page 55, which see: In the figure $A\ B\ C$ is the parallel, $A\ P$, $B\ P$ and $C\ P$ represent meridians equally distant. $E\ A$ is perpendicular to $A\ P$, and $D\ F$ perpendicular to $B\ P$. Then $D\ F\ E$ is the convergence of the meridians for the distance $A\ B$. $B\ A\ F = \frac{1}{2} D\ F\ E$. Therefore, if we were to set our instrument at A and run a perpendicular to the meridian to F, and again set up at F and measure the angle $D\ F\ E$, and set $\frac{1}{2} D\ F\ E$ off toward the pole, we would run a line from F parallel to $B\ C$. In practice, the distance $B\ F$ is neglected. To be strictly correct, we should go back to A and set off $\frac{1}{2}\ DFE$ from EA toward the pole. Hence Burt's rule: "Take half the difference between the back-sight and the fore-sight, and set it off on the side toward the pole." By the term *fore-sight* is intended the perpendicular to the meridian. Notice that this requires equal distances between stations, but notice farther that the instrument may be set any number of times between A and B, provided the line is prolonged by back and fore-sights.

This method was and is now extensively used on the United States Public Land Surveys. It is simple but is not accurate. It cannot be recommended for extreme accuracy on account of the many instrumental errors of the solar compass. "Lines run with a solar compass have been found 10′ wrong, as determined by a transit line."

2. *By Change of Azimuth.*—This method consists in computing the change of azimuth for the several distances that the instrument is moved. The formula for this correction may be deduced from spherical trigonometry, as follows:

In fig. 20, AC and AB are meridians. CB is the great circle tangent to the parallel at B. D is a point on the required parallel. The angle $ABC = 90°$. The angle at C differs from a right angle by the convergency of the meridians. This difference $= 90° - C = 2\ DBC$. In the right angled spherical triangle ABC we have

$$cos.\ C = tan.\ a\ cot.\ c.$$
$$cos.\ C = sin.\ (90° - C).$$

The side a of the triangle is measured in linear units. Let k = this distance, then the number of seconds of arc in the side $a = \frac{k}{\rho\ arc\ 1''}$, in which ρ is the radius of curvature of the earth's surface. $c = 90° - Lat.$ and $cot.\ c = tan.\ Lat.$ Making the substitutions in the formula

$$sin.\ (90° - C) = tan.\ \frac{k}{\rho\ arc\ 1''}\ tan.\ Lat.\ \text{and}$$
$$sin.\ 1''\ (90° - C)'' = tan.\ 1''\ \frac{k}{\rho\ arc\ 1''}\ tan.\ Lat.,$$

but $sin.\ 1'' = tan.\ 1''$, hence

$$(90° - C)'' = \frac{k}{\rho\ arc\ 1''}\ tan.\ lat.$$

= the convergency of the meridians for the distance k. The amount to be set off from the perpendicular toward the pole is half the convergency. Therefore the change of azimuth in seconds $= \frac{k}{2\ \rho\ arc\ 1''}\ tan.\ Lat.$

If k is given in miles, the correction $= 26'' - k\ tan.\ Lat.$ with sufficient accuracy.

The same result may be obtained from the formula for difference of azimuth, as given on page 64.

Practically, the method by change of azimuth is not very good, since the change is so small that it cannot be set off with the instrument. Usually when a parallel is required, it is in connection with a land survey, and if run by this method the instrument will be compelled to wait while the men are setting the corners.

3. *By Offsets.*—This method consists in starting perpendicular to the meridian and running on a great circle by back and fore-sights. Having run the great circle, it is only necessary to measure the proper offsets to the parallel. The advantage of this method is that the instrument can be manipulated to establish the next point while the corner post of the last one is being set. When the offsets become inconveniently long, the instrument can be moved to a point on the parallel and a new great circle run as before. The work should be checked by frequent observations for azimuth, every night if at all possible.

To compute the offsets, apply the formula—

$$tan.\ \tfrac{1}{2}\ (b-c) = tan.\ \tfrac{1}{2}\ a\ \frac{sin.\ \frac{1}{2}\ (B-C)}{sin.\ \frac{1}{2}\ (B+C)}$$

to the triangle ABC, Fig. 21.

$$tan.\ \tfrac{1}{2}\ (b-c) = \left(\frac{b-c}{2}\right)''\ tan.\ 1'' = \left(\frac{b-c}{2}\right)''\ arc\ 1'' = \frac{d}{2\rho},$$

d being the offset DC.

$$tan.\ \tfrac{1}{2}\ a = \tfrac{1}{2}\ a''\ arc.\ 1'' = \frac{k}{2\rho}$$

$$sin.\ \tfrac{1}{2}\ (B-C) = \tfrac{1}{2}\ (B-C)''\ sin.\ 1'' = \frac{k}{2\rho}\ tan.\ Lat.$$

$\frac{1}{2}\ (90° - C) sin.\ 1'' =$ as per the result of the previous method. Making these substitutions in the first formula we have—

$$d = \frac{k^2}{2\rho}\ tan.\ lat.$$

The same formula may be obtained directly from the result of the last method thus—

$$d = k\ sin.\ DBC = k\ sin.\ \tfrac{1}{2}\ (\text{convergency}) = k\ sin.\ \tfrac{1}{2}\ \frac{k}{\rho\ arc.\ 1''}\ tan.\ Lat. = k\ sin.\ 1''\ \frac{k}{2\rho\ arc\ 1''}\ tan.\ Lat. = \frac{k^2}{2\rho}\ tan.\ Lat.$$

If k be given in miles and d required in feet, we have $d = 0.6673\ k^2\ tan.\ Lat.$ Usually the points to be established will be at regular intervals, and therefore the offsets may be computed and tabulated. This is by far the best method.

CORRESPONDENCE.

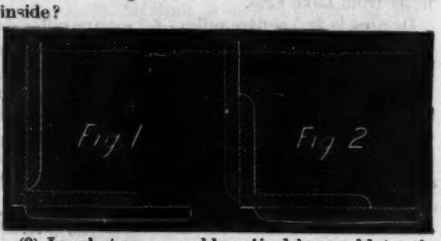
POSITIONS OF ANGLE IRONS.

ST. JOSEPH, July 21, 1881.

EDITOR ENGINEERING NEWS:

In reference to an article in your journal, number 28, July 9, 1881, about "An Accident in Cincinnati," I wish to ask the favor of answering a few questions through the columns of your paper if time and room allow.

(1) Would it really strengthen the tank by putting the lower angle iron at the outside instead of inside?



(2) In what way would *vertical* bars add to the strength of the rings?

(3) Would a few rivets not driven home cause a tear in the sheets?

(4) Is half-inch steel plate safe enough to sustain the pressure of a water column, 40 ft. high and 100 ft. in diameter, for any length of time?

Yours, etc., AN ENGINEER.

ANSWER.

No. 1. No.

No. 2. They would not "add to the strength of the rings," but would stiffen the structure.

No. 3. They might.

No. 4. Yes, if of proper material properly put together.

Our correspondent will observe, by looking at the article in question, that the opinions expressed therein are those of the *Cincinnati Commercial* and not of this journal.

IRON CASTINGS.

Cast iron was not in commercial use before the year 1700, when Abraham Darby, an intelligent mechanic, who had brought some Dutch workmen to establish a brass foundry at Bristol, England, conceived the idea that iron might be substituted for brass. This his workmen did not succeed in effecting, being probably too much prejudiced in favor of the metal with which they were best acquainted. A Welsh shepherd boy named John Thomas had, some little time previous to this, been received by Abraham Darby into his workshops on the recommendation of a distant relative. While looking on during the experiments of the Dutch workmen, he said to Mr. Darby that he thought he saw where they missed it. He begged to be allowed to try; so he and Mr. Darby remained alone in the workshop all night, struggling with the refractory metal and imperfect molds. The hours passed on and daylight appeared, but neither would leave his task, and just as morning dawned they succeeded in casting an iron pot complete. The boy entered into an agreement with Abraham Darby to serve him and keep the secret. He was enticed by the offer of double wages to leave his master, but he continued faithful, and from 1709 to 1832 the family of Thomas were confidential and much valued agents to the descendants of Abraham Darby. For more than one hundred years after the night in which Thomas and his master succeeded in making an iron casting in a mold of fine sand contained in frames and with air-holes, the same process was practiced and kept secret at Colebrook Dale, with plugged keyholes and barred doors.

NOTE ON GORDON'S FORMULA FOR LONG COLUMNS.*

The familiar form of Gordon's formula (frequently, but improperly called Rankine's) is the following:

$$P = \frac{fS}{1+a\frac{l^2}{r^2}} \quad \ldots\ldots(1)$$

In which, P = resistance of the column;
S = area of cross-section in inches;
f = greatest intensity of stress (compressive) per square inch;
l = length of column;
r = radius of gyration of cross-section in same unit as l;
a = an empirical coefficient.

Neither f nor a can be considered constant, but both must vary with different circumstances of material, manufacture, length, condition of ends, etc.; a, also, is a function of the coefficient of elasticity, a very variable quantity. Both these quantities, therefore, must be determined by experiment.

Let $\frac{P}{S} = p$ = mean intensity of stress; let $a = x$, and let $c = \frac{l^2}{r^2}$. Eq. (1) may then be changed to the following form, if $f = y$:

$$p = \frac{y}{1+cx} \quad \ldots\ldots(2)$$

As is well known, for round or free end columns x will take the place of $4a$, and of $1.8a$ for columns with one end round and one end flat.

In Eq. (2) there are two unknown quanties, y and x. If p is determined experimentally for two columns having very different values of c, the two following equations may be written:

$$y = p'(1+c'x) \quad \ldots\ldots(3)$$
$$y = p''(1+c''x) \quad \ldots\ldots(4)$$

By the simple elimination of y:

$$x = \frac{p''-p'}{c'p'-c''p''} \quad \ldots\ldots(5)$$

Either of Eqs. (3) or (4) will then give y. In selecting experimental results for insertion in Eq. (5), care should be taken to make the difference $(p''-p')$ and $(c'-c'')$ as large, numerically, as possible, in order that the errors of experiments may form the smallest possible proportion of the first. If there are a great number of experiments the method of least squares might be advantageously used to form the equations of condition, similar to (3) and (4), if the sources of error incidental to the experiments are not too many and great. But the method of least squares eliminates *the errors of observation only*, or those which, in long series of observations, are equally liable to occur in either direction, and not extraneous errors of an accidental nature. In experiments on large long columns there, are many sources of errors of the latter kind, and the number of experiments on any kind of column has hitherto been only small. It is, therefore advisable to use Eqs. (3), (4) and (5) in connection with the simple tentative method, on the experiments to be used.

The long column experiments made under the direction of the Cincinnati Southern Railway, and published in Mr. Lovett's report, November, 1875, are probably the most valuable ever made.

In the accompanying table, the column headed "*Exp.*" is taken from the account of those experiments. The columns x and y were found by trial by the aid of Eqs. (3), (4) and (5). The column headed "p" was calculated by Eq. 2. The degree of confidence to be attached, therefore, to the values x and y can be determined at a glance. The figures in columns y, p and *Exp.* denote pounds.

The differences between the results of the columns "p" and "*Exp.*" are not greater than experimental differences. Yet the results are a little too large for swelled keystone columns, and a little too small for straight open columns of the same kind. It was desired to make the same set of values for x and y cover as many columns as possible. If greater accuracy is desired x may remain the same and y may be taken at:

36,000.00 pounds for swelled columns, and
39,500.00 pounds for straight open columns.

Expressing all results in concise formulæ, there may be written:

KEYSTONE COLUMNS.

Flat ends swelled ..... $p = \frac{36000}{1+\frac{l^2}{150r^2}}$;

*Read by Wm. H. Burr, C. E., before the Pi Eta Scientific Society, Rensselaer Polytechnic Institute, Troy, N. Y.

BURR'S TABLE TO NOTE ON GORDON'S FORMULA FOR LONG COLUMNS.

x	y	p	Exp.	Kind.	Section.
$\frac{1}{100}$	38300.00	37600.00	33600.00		
"	"	32000.00	28800.00		
$\frac{1}{50}$	"	25100.00	24100.00	Flat Ends,	
"	"	32700.00	30900.00	Swelled.	
"	"	25500.00	21100.00		
"	"	25500.00	25400.00		
"	"	25900.00	25000.00		
"	"	25800.00	27500.00	Flat Ends, Open. Straight.	KEY STONE. OPEN.
"	"	25500.00	30000.00		
"	39500.00	33100.00	30000.00		
"	"	32200.00	32000.00	Flat Ends, Closed. Straight.	CLOSED.
"	"	24900.00	27800.00		
$\frac{1}{150}$	38300.00	21300.00	22000.00	Pin Ends, Swelled.	
$\frac{1}{150}$	39000.00	30000.00	30000.00		
"	"	32400.00	33200.00	Flat Ends, Square.	
"	"	30600.00	30200.00		
$\frac{1}{170}$	"	25800.00	25500.00	Pin Ends, Square.	
$\frac{1}{50}$	42000.00	39000.00	37500.00		
"	"	34000.00	30000.00		
"	"	33500.00	34800.00	Flat Ends.	PHŒNIX.
"	"	33500.00	36600.00		
$\frac{1}{150}$	"	21650.00	21700.00	Round Ends.	
$\frac{1}{150}$	36000.00	23700.00	23700.00		
"	"	31500.00	31500.00	Flat Ends.	
$\frac{1}{110}$	"	24600.00	24000.00	Special Round Ends.	AMERICAN BRIDGE CO.
$\frac{1}{110}$	"	24100.00	26700.00		
"	"	27400.00	26500.00	Pin Ends.	
"	"	23600.00	22000.00		
"	"	26400.00	27800.00	Special Pin Ends.	

Flat ends, straight { open or closed } ..... $p = \frac{39500}{1+\frac{l^2}{150r^2}}$;

Flat ends, open { swelled straight } ..... $p = \frac{38300}{1+\frac{l^2}{150r^2}}$;

Pin ends, swelled ..... $p = \frac{38300}{1+\frac{l^2}{150r^2}}$;

SQUARE COLUMNS.

Flat ends ..... $p = \frac{39000}{1+\frac{l^2}{150r^2}}$;

Pin ends ..... $p = \frac{39000}{1+\frac{l^2}{170r^2}}$;

PHŒNIX COLUMNS.

Flat ends ..... $p = \frac{42000}{1+\frac{l^2}{150r^2}}$;

Round ends ..... $p = \frac{42000}{1+\frac{l^2}{150r^2}}$;

Pin ends (hypothetical) ..... $p = \frac{42000}{1+\frac{l^2}{110r^2}}$;

AMERICAN BRIDGE COMPANY'S COLUMN.

Flat ends ..... $p = \frac{36000}{1+\frac{l^2}{150r^2}}$;

Round ends ..... $p = \frac{36000}{1+\frac{l^2}{110r^2}}$;

Pin ends ..... $p = \frac{36000}{1+\frac{l^2}{90r^2}}$;

CAR WHEELS.

Car wheels are now kept in their place without being keyed on. In former times they were almost sure to precipitate an accident; besides, keys would drop out by the constant jar and be weakened by the axles and wheel. Axles are turned to fit the wheel snugly, and are driven in place by hydraulic pressure. Previous to being driven the axles are covered with a thin coat of white lead and oil, which hardens in a short time and holds the wheel so firmly in place that a pressure of from 100 to 140 tons is required to remove a broken axle from the wheel in which it is placed.

COMPRESSED GUN COTTON.

BY M. EISSLER.

Through the systematic study of Abel, an eminent chemist, this material has now obtained quite a position in England, as by means of his analytical and synthetical researches he has found the causes of the instability observed in that substance, and has traced its occasional liability to undergo spontaneous combustion to the presence of minute quantities of foreign substances of comparatively unstabe character produced by the action of nitric acid upon resinous or fatty substances retained by the cotton fibers.

Some parts of his mode of manufacture may be considered comparatively safe, as he carries it on with the material in a wet, therefore uninflammable state. His mode of converting it into a minute state of division is the main improvement which he introduced, as it allows of a more perfect cleansing, and then its conversion into highly compressed masses is the main feature of his mechanical modifications; otherwise, he admits, one has only to follow Von Lenk's plan, and adhere to his rules.

The process of manufacture, as pursued by Prentice & Co. or the Liverpool Cotton Company, is as follows:

Clean cotton, picked as free as possible from foreign matter, is brought into a uniform and open condition, by being passed through a carding engine.

The rolls thus obtained are dried in a triple cylinder, by means of a steam jacket.

When completly dried it is placed in large tins and carefully covered.

After standing in these till quite cold, the cotton is weighed out in quantities of one pound each, and carried by a boy to the dipping vessel. Here each pan is charged with about twelve gallons of a mixture of three volumes of sulphuric acid, 1.84 specific gravity, and one volume of the strongest nitric acid, the whole being kept cool during the action by currents of cold water, which circulate around the vessel.

In this mixture the cotton is dipped, and after it has been in about three minutes the workman lifts it on to a grating, just above the acids. Then, with a movable lever, he gently squeezes it until, roughly speaking, it retains about ten times its weight of the liquid.

Thus saturated with the acids, it is allowed to remain in well-covered earthenware pots for twenty-four hours, the pots during this time standing in a shallow trough containing water to keep down the temperature, sufficient acid being added to cover the cotton. The chemical change in the cotton is now complete, and the further processes are for washing and pressing.

First, the large excess of acid is driven off by a centrifugal machine, and the waste acid is caught by a jacket surrounding the revolving portion of the machine, and collected in a receiver. These machines are on the principle of the wringing machines employed by laundries to dry clothes (whizzer).

On leaving the centrifugal machine the gun cotton has to be washed. This operation also requires great care, because the acids which the gun cotton yet retains would give rise to a considerable development of heat if mixed slowly with water. At such an increased temperature the gun cotton would be decomposed, or "fired," as it is technically called. Therefore it has to be brought at once in contact with a large body of water.

To perfect the washing, the cotton is subjected to the action of water for one, two, or three weeks, and afterward boiled in large vats by the injection of steam. By this latter operation the less stable compounds are destroyed and extracted, and the purified gun cotton is transferred to the heating tanks.

This is a simple contrivance for converting the gun cotton into pulp. It is a machine similar to the one used in paper mills and called Hollander.

The pulp is now removed from the tank to a poacher, where it is agitated with a large quantity of water by a wheel, and here it has to be washed till it answers the heat test, which the chemist now applies.

When his report is favorable, the pulp is transferred to a vat and mixed with a small quantity of caustic soda.

The further processes of abstracting the water and molding the pulp into cartridges or other shapes is performed by hydraulic pressure or other pressing machines, which are very ingeniously arranged, and great credit is due to the manufacturers for the nice and elaborate machinery they have adopted for the treatment of their products.

Where the cartridges are made under light pressure they are put on perforated trays, and dried in chambers heated with hot air.

In establishments where the gun cotton is mixed with oxidizing salts, these are mixed in regular gunpowder incorporating mills, of light but very elegant pattern.

The great difference between the process of manufacture described above and that of Von Lenk consists in the introduction of the pulping operation devised by Abel. This improvement admits of very searching purification, and also of more reliable testing, and of the subsequent compression.

PROPERTIES.

Before it has been reduced to pulp, gun cotton has the same appearance as the original fiber, but it is harder to the touch; it has neither taste nor smell.

It is insoluble in water, ether or alcohol. Dilute acids and alkalies have no action upon it, but a lower substitution product is formed by the action of nitric acid of the specific gravity, 1.45.

Strong sulphuric acid dissolves it with difficulty.

Caustic potash dissolves it.

Much uncertainty prevailed for a long time as to whether gun cotton was liable to spontaneous combustion or not. As I have shown in my former articles, it had been used in Austria for twelve years, where it underwent the severest tests, and was held by the best authorities to be perfectly safe, but it was at last rejected on account of its instability, and also that other governments abandoned it after experimenting with it extensively. Prof. Abel, in his valuable researches, ascribes the reason of its decomposition to be mainly due to impurity, generally resulting in the process of manufacture, from the action of the acids on resinous matter in the imperfectly washed cotton, and certainly the experience of the last few years speaks in favor of his theory, as no accidents from that score are on hand.

It is only in late years that the true cause of chemical instability, which belongs to the whole class of nitrated organic compounds, has been clearly defined, it being the life question of our modern high explosives.

After their nitration a certain portion of acid—sulphuric, nitric and hyponitric—always adheres to those compounds, more or less, according to their form and structure. From a liquid explosive substance like nitro-glycerine, the acids are easily washed out by churning it with water first and then with alkaline solution. But a granular, flocky, or fibrous material, like cotton, retains the acids with far greater tenacity, particularly the nitrous and hyponitric acids, which every nitrated organic compound has a strong tendency to retain.

It is quite clear that if there is hyponitric acid present, that highly corrosive material, which attacks almost every organic compound, even at the ordinary temperature, must be removed; if not, it will slowly but surely lead to an incipient decomposition, which, acting on a nitrated substance, sets free portions of dioxide of nitrogen or hyponitric acid.

From nitro-glycerine the corrosive acid is washed out with the utmost facility, and from the moment when the importance of that operation became fully appreciated it has never been neglected. Hence the chemical stability exhibited by dynamite under all conditions of climate.

Although nitro-glycerine has exhibited, upon the whole, greater chemical stability than gun cotton, yet it acquires that superiority only after being thoroughly purified from acid at the factory. When it contains free hyponitric acid it cannot be stored at all in hot weather, and even during the course of its manufacture it has several times given rise to a decomposition, ending with explosion and loss of life. The instability of the crude article contrasts so strongly with the stability of the pure nitro-glycerine in dynamite as to remove every trace of doubt regarding the decomposing influences of the adhering acids.

FUMES.

Among the most grievous complaints of miners about modern explosives is the poisonous nature of the fumes emitted, which exposes them to most serious inconveniences.

The gaseous products of the explosion of gun cotton differ from those of nytro-glycerine, as gun cotton lacks 24.24 parts of oxygen in 100 for the complete conversion of its carbon into carbonic acid, consequently we have the following to be the percentage composition of the resulting gases:

Carbonic oxide	28.55
Carbonic acid	19.11
Marsh gas	11.17
Nitric oxide	8.83
Nitrogen	8.56
Aqueous vapors	21.93
Total	98.15

The large amount of carbonic oxide is very deleterious and even dangerous when pure gun cotton is exploded in a close place.

It is very clear to my mind why English manufacturers have adopted the admixture of oxidizing salts (saltpeter, nitrate of baryta) with gun cotton, as the oxygen contained in the salts effects a more complete combustion, rendering the resulting gases less obnoxious than those resulting from pure gun cotton.

GUN COTTON IN MINING OPERATIONS.

In the compressed form gun cotton is susceptible, like nitro-glycerine and its preparations, of explosion through the agency of an initiative detonation (cap). Compressed gun cotton may therefore be applied with the same facility as dynamite and analogous substances in all mining and blasting work. On a whole the mixture of gun cotton and salts is not as sensitive to concussion as dynamite, consequently an extra strong cap is required to detonate it. As the highest nitrated product of cellulose (trinitro) still demands 24.24 parts of oxygen for the conversion into carbonic acid of the carbon in 100 parts, it is evident that the most explosive gun cotton producible must be inferior in explosive power to nitro-glycerine, which contains a very slight excess of oxygen. Some authorities claim that, in spite of its high state of compression to which English manufacturers have brought it, its strength is much less than dynamite.

Here, also, it is clear why the English manufacturers have adopted the use of an admixture of oxidizing salts, as stated before; but the question will present itself: Is not the quickness of the explosion less rapid through this admixture than of pure cotton?

Where great local action is required, nitro-glycerine or dynamite competes advantageously with those substances. Some careful comparative experiments made by the German engineer corps, at Graudentz, with Nobel's dynamite and Abel's compressed gun cotton (made at the English government works), demonstrated that dynamite produced somewhat greater local or shattering effects than gun cotton.

The plastic condition of dynamite and similar preparations gives them an advantage over the rigid, compressed gun cotton in blasting operations, as plastic powders may be inserted more readily into rugged and uneven bore-holes, and may be made, by application of pressure, thoroughly to fill the part charged. Every miner is aware of the importance of having his charge well home in the bottom of his hole, filling the whole cavity. And this can only be accomplished with a plastic powder.

The increased effect derived from this mode of applying plastic explosives is far greater than is generally believed.

Volume for volume, it is impossible to put the same weight in a bore-hole for a certain given space; or, in other words, if one has a cartridge of dynamite, say one inch diameter and four inches long, and one of compressed gun cotton of the same size, the dynamite cartridge will weigh more; consequently one has more explosive material in the same space, owing to the higher specific gravity of dynamite, and as a consequence larger bore-holes are required when using gun cotton, which increases the cost of mining.

The cartridges of compressed gun cotton are rigid, stiff, and every miner knows there should be no air chamber round the charge, for the expansion which it causes not only lessens the power in proportion to its dilution, but actually decreases the tension of the gas in a much greater measure. Stiff cartridges cannot be introduced into a bore-hole without leaving a considerable air chamber round the charge, particularly as bore-holes generally deviate a great deal from the circular shape.

It is difficult to calculate even approximately the relative proportions of the unoccupied space and the charge, but certainly the loss will amount to considerable. When a loose mass of gun cotton is ignited in the air it burns rapidly away without any explosive effect. But if the ignition takes place in a closed chamber, the gases first produced immediately penetrate the mass of the cotton, and the whole is instantaneously decomposed. According to some authorities gun cotton will not explode below a temperature of 280° Fahr.

Gun cotton has the great advantage over dynamite that it does not freeze, and therefore needs no thawing out, which is appreciated in cold climates. It does not suffer from exudation, and when properly made has good keeping qualities.

One great advantage again of nitro-glycerine and its preparations is that they remain unaltered under water, and can be used in wet bore-holes with the same facility as in dry holes, and although compressed gun cotton, when containing 10 per

cent. or 15 per cent. of water, can be exploded, it requires a very strong exploder or a dry primer to accomplish it, consequently for work under water dynamite is preferred.

The cost of these two materials also differs greatly; the expense of producing gun cotton must be 20 per cent. or 25 per cent. higher than dynamite; therefore, when the question of competition arises, the latter has the advantage.

In the last six or seven years there have been brought forward in England (since Abel perfected his system of reducing gun cotton to a fine state of division and compressing it) several special preparations of gun cotton, for which peculiar merits are claimed by their advocates. One of those preparations, manufactured by the Gun Cotton Company, is a mixture of finely divided gun cotton and saltpeter. Another, the Tonite Company, at Faversham, mixes gun cotton with nitrate of baryta. Which of these is the best, practical experience alone can form the estimate.—*Mining and Scientific Press.*

CAST-IRON FLAT-HEADS.

On June 1 last one of the three steam boilers used by Messrs. Gaffney & Co., Philadelphia, burst, killing three persons and injuring a number of others. From the *American Machinist* of July 23 we take the principal points in regard to the construction of the boiler and the appearance of the parts after the accident.

The front boiler-head was shattered into four pieces, the line of fracture passing through the man-hole opening radially, and circumferentially through that part of the head adjacent to where the metal had been reinforced by the thickening up of the flange near its rim. The force of the explosion destroyed the setting and projected the boiler in almost a direct line a distance of some 500 feet. The exploded boiler was of the plain cylinder construction, 3 ft. diameter by 30 ft. long, shell of full quarter-inch iron, plainly stamped in many places "Best Flange," T. S., 50,000 pounds. The heads were flat cast iron 1⅞ in. thick, filleted at flange. The man-hole in front head was 11 by 15 in., strengthened by a boss surrounding it 1¾ in. wide by 2¼ in. thick. The jut entered through nozzle in front head, which also served as a blow-off. The boiler was built for a working pressure of 80 pounds steam, and placed in brick setting alongside of Nos. 1 and 2 boilers by the same builders.

From the *Philadelphia Record* of the 14th inst. we take the following: "A remarkable experiment, which is likely to create considerable discussion in the engineering world, was made at Frankford yesterday. It was an endeavor on the part of a firm of boilermakers to refute the theories advanced by a recent coroner's jury, which was composed of picked experts. The firm in question, Messrs. Sidebotham & Powell, were the builders of the boiler which exploded with such disastrous results, at the dye works of Gaffney & Co., in Kensington, in the early part of June. The boiler had been placed in position, new from the workshop, less than a month before, and had been passed as perfect in every particular by the inspectors of the Hartford Company. The jury, however, ascribed the explosion to the improper use of cast-iron in the flat-head of the boiler, and the inspectors who certified to its safety were severely censured. The builders, instead of airing their opinions in print, determined to demonstrate that cast-iron flat-heads were as safe as could be demanded by any system of inspection. They were the more anxious to take this step from the fact that in the course of a business that has covered over 20 years, only two boilers from their workshops have exploded. Accordingly, they set about the construction of a boiler the counterpart in every respect, save that of length, of the one which created such havoc in Kensington, for the purpose of subjecting it to the hydrostatic test until it burst, the intention being to ascertain how much pressure would be required to break a flat cast-iron head. The boiler, which was completed a few days ago, was 36 in. in diameter, 42 in. in length, and constructed of the substantial iron known in the trade as No. 3 Birmingham wire gauge. The door of the man-hole was the same which did a similar service in the Gaffney boiler.

"Four o'clock yesterday was the hour fixed for the test. Invitations had been sent to the members of the jury which had pronounced against these heads and to the Commission on Steam Boilers appointed by Mayor Stokley.

"When everything was in readiness the pressure was applied. The usual sapping at the rivets was apparent when the gauge registered 100 pounds, but beyond this the boiler did not exhibit any symptoms of a strain. At 130 pounds the water began to ooze through a small sandhole in the head, above the man-hole, showing that the head was slightly defective. The pressure was then reduced while Inspector Overn affixed a contrivance to the rear end for the purpose of measuring the extent of expansion. Pressure was again applied until the gauge marked 140 pounds, then 160, 180, and 200. At this amount of pressure the seams on the side of the boiler began to weaken, and from one spot a spray of water as fine as steam was discharged. At 250 pounds this had increased to a good-sized squirt, and at 350 the water was issuing with such force as to be thrown four feet away. Still the heads remained intact. At 400 pounds half a dozen similar fissures appeared in a close row in the same seam. The pressure was then gradually increased to 425 pounds, and the lookers on were beginning to wonder whether the boiler would hold out forever, when a sudden crack was heard in the front head and the water commenced to run down from a fissure extending half way across the head. The gauge showed that the boiler had given out at a pressure of 450 pounds, and a subsequent examination showed that the break had commenced at the leaky sand-hole before mentioned. Had it not been for this defect the head would probably have stood an additional 50 pounds pressure before giving way. The measurements taken by Inspector Overn showed that the rear head had expanded 1-16th of an inch at 200 pounds and 3-16th at the time of the break.

"Several weeks ago, when the Hartford Company decided not to pass any boilers with flat cast-iron heads over 32 inches in diameter, City Inspector Overn addressed a communication to City Solicitor West, asking what authority, if any, the City Inspector could exercise in the same direction, and also requesting advice as to how he should govern himself in passing upon steam boilers. In reply, the City Solicitor says that the questions are more fitted for a mechanical expert than for a lawyer, but that legally he would advise the Inspector when in his judgment a boiler is safe to approve it and give a certificate, without regard to its mode of construction or the material used. Mr. Overn has consequently decided to adhere to his usual practice of passing all boilers with the obnoxious heads if they have safely withstood the cold water test."

AN EXHIBITION OF ELECTRICITY.

The Paris International Exhibition of Electricity will be opened on the 1st of August. Thanks to the energetic activity of the Commissaire General, M. Berger, and to the support afforded by the Minister of Posts and Telegraphs, M. Cochery, all will be ready at the appointed date to receive in the Palais de l'Industrie the machines, instruments and models which the electricians of the whole world intend to exhibit at this great scientific display of modern industry. The demands from every country are so important that the palace, which was built for the universal exhibition of 1855, will be hardly sufficient to contain all the exhibits. The exhibition will be open day and night, floods of light being thrown out by all kinds of French and foreign electric lamps until 11 p. m. The motive power will be supplied by powerful steam-engines placed in the south gallery. The western end of the palace is allotted to the French, and the eastern to the foreign exhibitors. The French section will be lighted by a special system, the foreign one by the English, American, Belgian or any other foreign systems, many of which have not been tried in France. Every room on the first story will be lighted by a special system of lamps and burners, thereby affording an excellent occasion for comparing the advantages and deficits of each system of electric lighting apparatus. Every exhibitor will be at liberty to arrange his apparatus in the most advantageous manner. There will be several models of powerful burners for street lighting and of moderate sized lamps for domestic use, and it will therefore be very easy to compare the steadiness, homogeneousness of the light, and practical value of each system.

A monumental staircase placed in the middle of the hall will lead to the first story, under which will be restaurants, buffets, etc. Opposite to it will be the pavilion of the ministry of posts and telegraphs; then the pavilion of the city of Paris, which will contain the models of all electric clocks, alarm bells, etc., used by the Parisian municipality. In the center of the palace will be erected a first-class light-house, the apparatus of which will be lit by electric light. Room 1 will be lit by the Soleil lamps, and contain paintings and objects of art. Room 2 will be devoted to the applications of electric light to stage scenery a stage being erected therein where the Werdermann system will be used. Room A, at the landing of the monumental staircase, will be transformed into a saloon for the president of the republic; it will be lit by Regnier lamps. Rooms 3 and 4 will be arranged as an apartment, with bedrooms, drawing-room, dining-room, billiard-room, library, hall, kitchen, etc., and be lit by Jamin and Werdermann lamps. This apartment will contain all known applications of electricity to domestic use, from the safe, protected by electric bells, to electric piano and electric marking boards for billiards. Rooms 5 and 6 will contain the especially scientific portions of the exhibition. Room B will be lit by the Jablochkoff system.

Further on the rooms 7 and 8 will not fail to afford great attraction. They will be transformed into six small boudoirs, well isolated from outside noise by special partitions, and visitors will there listen to the pieces of the Comédie Française and Opera placed in telephonic communication with the Palais de l'Industrie. A series of telephones will enable several persons to listen at the same time to the music of the Opéra or to Molière's verses. Two boudoirs will serve for the Comédie Française and four for the Opéra. This extraordinary exhibition is organized by the Société Générale des Téléphones, in the name of M. Ader, the inventor of the apparatus now in use, and of Breguet, its constructor. Room 9 will be devoted to electrotherapy. Room 10, lit by MM. Sautter, Lemonnier & Co., will contain fire alarms, level indicators, etc. Room 11 will be devoted to photography; M. Liebert will there photograph visitors by electric light. Room 12 will be especially assigned to the Gramme electric machine, etc. The instruments of precision, coils, galvanometers, will be arranged in room 13, lit by Siemens. Rooms 14, 15 and 16 will contain every instrument connected with electric telegraphy. Room G, in the middle of the palace, will contain the exhibition of the Société Générale des Téléphones, and be lit by Heran Maxime lamps and by Jasper de Liege, Anatole Gerard and Thomassi burners. The different models of electric batteries will occupy room 17. A retrospective exhibition will be organized in room 18. The College de France will send Ampere's table, and the Conservatorie des Artes et Metiers the ancient machine constructed by Armstrong. Clocks and watches will occupy room 20, lit by Gibb's system. A reading-room and bibliographic exhibition will occupy rooms 19 and 21, lit by the Lontin and Daft systems. Lectures will be delivered in room D, lit by MM. Swan and Brush; and finally rooms 23 and 24 will contain Mr. Edison's wonderful inventions, including the much-spoken-of electric lamp, which is said to reduce the others to the power of ordinary candles. The southern gallery of the first story will contain a small electric railway, similar to the model proposed to replace the postal pneumatic tubes now in use. From place to place telephonic boxes will enable subscribers to the telephonic company to communicate with every part of Paris. A Siemens railway will be constructed from the Place de la Concorde to the east gate of the palace, affording an appropriate mode of conveyance to enter this wonderful electrical domain, which will remain open from the 1st of August to the end of November.—*Galignani's Messenger.*

MEXICAN ITEMS.

CITY OF MEXICO, July 27.—The State of Chihuahua, on the Texas and New Mexico border, has granted to the Central Construction Company permission to erect a railroad bridge over the Rio Grande at El Paso Del Norte. A similar privilege has already been conceded by the Mexican Government, and there will probably be no great delay in beginning the work of construction.

CITY OF MEXICO, July 26.—The difficulty having terminated between the Central Railroad and city council and the inhabitants of Paso del Norte, the Mexican Government gave orders to continue the works on the bridge of the Rio Bravo. The President denies that he authorized the agent at London to make arrangements with English bondholders. The government will not make, for the present, any arrangements.

ALBANY, July 22.—Articles of association of the Mexican, Oriental, Interoceanic & International Railroad Company have been received by the Secretary of State and have been laid before the Governor for approval. The articles state that on June 7, 1881, a contract was entered into by and between the republic of Mexico and the International Railway Improvement Company granting certain

rights and powers, with a subsidy in aid of the construction and operation of a railroad and telegraph and branches within the republic, and the contract provided that said rights and powers could be transferred to one or more companies which might be organized for that purpose. The International Railway Improvement Company does not contemplate the permanent maintenance and operation of a railroad and telegraph, as by the contract required, but only the construction of the same for other companies or individuals; and the State of New York, having expressly authorized the incorporation of companies for the permanent maintenance of railroads and telegraphs beyond the limits of the United States, Jay Gould, Russell Sage, Sidney Dillon, Norvin Green, John F. Dillon, Thomas T. Eckert, M. Dodge, of New York; Ulysses S. Grant and Francis de Gress, of the City of Mexico, with others, have formed the above-named company. The company is to continue for a period of 99 years from date. The road is to begin at a point on the Rio Grande between Laredo and Reynosa, continuing south between longitude 1° west and 2° east of the meridian of Mexico, touching at San Fernando and Santander, joining with a branch road from thence to Ciudad Victoria, to be extended as far as San Luis Potosi; also, branches to Matamoras and the bar of Jesus Maria. In case this port should be opened to coasting and foreign trade, the trunk line shall continue from Santander Jimenez to the City of Mexico, by the most convenient ascent to the table-lands, and may continue from there to a point on the Pacific coast situated between the meridians 0° and 6° west longitude of the capital of the republic. The main line may divide or branch off before its ascent to the table-lands, passing by Papontha and Mizantia, with its terminus in Vera Cruz, with branch roads to Soto La Marina, Tampico, Tuxpan, and Fecoluthuar Nautla. The amount of capital stock is based at $25,000,000, divided into 250,000 shares of $100 each. The above-named persons are to act as a board of directors. Jay Gould takes 100 shares; Sidney Dillon, 100; Russell Sage, 100; Thomas F. Dillon, 100; Amos L. Hopkins, 100; Thomas T. Eckert, 100; Norvin Green, 100; Thomas W. Pearsall, 100; Gen. U. S. Grant, 100, and Francis De Gress, 100.

FOREIGN INTELLIGENCE.

M. Prodhomme manufactures a nitro-glycerine, which he calls pyronitrine, by having certain chemical products react on each other, the residium of which form a part of the elements of common black powder. The nitro-glycerine formed by by the reaction does not remain in a free state in this compound, but combines with the other elements. The bodies used are the following:

1. A nitrate, which may be ordinary saltpeter or nitrate of soda, or of baryta, lime, etc.; or, a mixture of these.

2. An organic matter such as tan, cellulose, sawdust, which are to form with the nitric acid of the nitrate the constituent elements of nitro-glycerine. The reaction of these bodies is formed by a small quantity of sulphuric acid, which can be obtained from any soluble sulphate, as that of lime, soda, etc.

Mr. Lewin manufactures under the name of *petralithe*, an explosive material from the following mixture: Nitro-glycerine, 60 parts; azotate of potassium, soda or ammonia, 16 parts; cetoceum, 1 part; carbonate of lime, 1 part; lignine, 6 parts; charcoal, white moss (sphagnum), animal black, 16 parts.

GENERAL INTELLIGENCE.

☞ *We solicit and are always pleased to publish in these columns any items of interest that may be furnished us.*

GAS AND WATER.

The Winnipeg (Canada) Water-Works Company invites tenders for construction bonds to the amount of $30,000.

The water commissioners of Toronto, Canada, have appointed an inspector whose duty it will be to prevent waste by water takers. The daily consumption during the year averaged 1,250,000 gallons.

Parkersburg, W. Va., is getting ready to have water-works. A company has been organized with a capital of $125,000, to give the city 50 plugs, 10 miles of pipes, 2 reservoirs, capacity 1½ million gallons, on a hill 185 feet above city, 2 1-million gallon pumping engines, for a yearly rent of $5,000. Frank Schefold, of New Albany, Ind., is consulting engineer.

The plans and specifications of the dams and water-pipes for the additional water supply for the borough of Danbury, Conn., will soon be ready to receive bids from contractors. The engineer, B. H. Hull, of Bridgeport, will run the pipe line this week, which will be about 17,000 feet long, 16-in. pipe; stone dam 30 feet high, 800 feet long.

Here is a conundrum for American gas companies. A painstaking German statistician has collected the prices for gas in all the leading cities of the world, and collated them, reckoning by the pfennig per cubic meter. London and Ghent are the most cheaply lighted cities in the world, rating at from 12 to 13 pfennigs; next come Amsterdam, Berlin and Brussels, at 16; Bordeaux, Antwerp and Rouen, at 16 or 17; up in the twenties we find Paris, Lyons and Marseilles; all these in countries where coal is so dear as to be a luxury. Then, with one tremendous jump, coming to a country which is founded on coal, up goes the rate into the highest fancy prices known—New York, 32; Boston, 34; Chicago, 43, and so on, like Tennyson's lark, up and up; coal selling in London at $5 per ton, and in Philadelphia at $4 per ton, and the price of gas precisely three times as much in the latter city as the first. This is one of the minor taxes by which hard-working Americans keep up bosses and rings.—*New York Tribune.*

ELECTRICITY.

Arrangements are now being make for giving Akron, Ohio, more electric light.

The United States Underground Telegraph Company has laid an experimental series of 72 wires, extending from the headquarters of the Fire Department, in Mercer street, this city, to Police Headquarters in Mulberry street. The wires are laid in long wooden boxes covered with a preparation of silica and other substances designed to exclude dampness and secure perfect insulation. It is said that if the present experiment is successful the system will be extended so as to include the police stations, engine-houses and fire-alarm boxes.

A Chicago dispatch says: The Messrs. Crane Brothers, of this city, have just now on hand a job which promises to put the lighting of cities by electricity to a practical test. It is the construction of a series of tubular towers, from 100 to 150 feet in height, composed of material similar to common gas-piping, and which, it is claimed, can be raised without guys to the height of 300 feet, in so substantial a shape as to be capable of withstanding the strongest wind-storm that ever blew. On the top of the tower is placed the electric light. This tubular tower is the invention of Mr. J. M. Adams, of Elgin. He says he has already tested the capacity of his tower to resist storms, having erected a big windmill upon one. The windmill was torn to pieces in a recent hurricane, but the tower remained unhurt—a veritable tower of strength. Like the members of Falstaff's ragged regiment, it presents no mark to the enemy. A company has already been formed, under the name of the "Elgin Tubular Tower Company," and articles of incorporation have been applied for. The city of Aurora has contracted with them for six towers, to be erected in that town as soon as they are completed, which will probably be before September. The Crane Brothers are at work upon them, and when finished Aurora will have an opportunity to enjoy a new sensation. Should the tubular towers turn out a success, they will very likely come into general use in larger cities—that is if the Brush light pans out well.

BRIDGES.

The bridge spanning Barnegat Bay from Sheepshead Point has been completed, and the Long Branch & Philadelphia Railroad will begin to communicate with the sea on the 25th inst. The bridge is one mile and three-eighths long, with a draw-bridge 240 feet.

Next week the contractors will begin to ship stone from Bedford, Ind., to New Albany, to be used in the piers upon which the new railroad bridge at that point over the Ohio River are to rest. It seems that the Jeffersonville bridge project has dissolved into thin air. At a meeting of the council of that city Tuesday night, the bonds for $250,000 heretofore issued to the Jeffersonville and Louisville Bridge Company and placed in the hands of a trustee, conditionally, were, under the provisions of the ordinance, ordered returned to the finance committee of the council, to be by them destroyed. The New Albany bridge killed the Jeffersonville project.

A dispatch from Canada says there are five bridges between Ingersoll and St. Thomas on the Credit Valley, and of these two are already completed. The first is a pile bridge, 200 feet long and 16 feet high, over Reynolds' Creek, and another of similar dimensions is located at Pine Creek. The structure spanning Kettle Creek at Belmont is of substantial trestle-work consisting of 14 spans, each 20 feet, and built upon piles, while the length is 380 feet, and the average height 32 feet. Tomacote Creek, near McTaggart's farm, is crossed by a trestle bridge 60 feet long and 20 feet in height. The most extensive bridge upon the line is the one in course of erection at Salt Creek, the construction of which is rendered more difficult from the nature of the high embankments and approaches, this requiring extension to a length of 320 feet. It is a double-deck trestle structure on piles, the average height being 40 feet

RAILROADS.

SHREVEPORT, La., July 27.—The track of the New Orleans Pacific has been completed to a point thirty-five miles south of this place, and the laying is progressing at the rate of over a mile a day.

The Chicago, Burlington & Quincy has introduced a unique device for cutting weeds along its track in Nebraska. It is attached to a flat car and drawn by a locomotive at the rate of twenty miles an hour.

SAN ANTONIO, Tex., July 27.—Work is rapidly advancing on the Laredo extension of the International & Great Northern Railroad. Sixty-seven miles are now completed south of Antonio.

The Chicago & Northwestern Railway Company has let the contract for the grading of the Winona and St. Peter line from Watertown thirty miles westward to the center of Clark County. On the branch from Huron up the James River valley track is laid for a distance of twenty-eight miles.

The company building the Toledo, Delphos & St. Louis narrow-gauge railroad recently put thirteen construction corps in the field at Ramsey, Ill. This road runs across the northern part of the State, and is rapidly approaching completion. It is the intention of the managers to have extensive connections with the Western system of narrow-gauge roads.

The trestle-work of Wheeling & Lake Erie Railroad over Pittsburgh, Fort Wayne & Chicago Railroad and the Cleveland, Mt. Vernon & Columbus Railroad, a mile west of Orrville, will be 2,000 feet long and will contain over 400,000 feet of lumber. Five hundred piles will be used in the foundation of the trestle.

The track of the Atlantic & Pacific is now laid for a distance of 200 miles west of the point of junction with the Atchison, Topeka & Santa Fe, and is being pushed west at the rate of nearly two miles per day. It is intimated that the company will shortly begin work from San Francisco eastward, as well as from San Diego. On Monday the engineers of the Atlantic Pacific Railroad line forwarded to Washington a certificate of 200 miles completed. The first-mortgage bonds of the road to the amount of $5,000,000 and $3,750,000 income bonds will be listed on the Stock Exchange, probably next week.

Not only American railroads but also the foreign roads are coming to the standard gauge of 4 ft. 8½ in. The Great Western railroad, of England, hitherto broad gauge, 7 ft., will in a few weeks cut this down to 4 ft. 8½ in. The Canadian roads are preparing to do the same, and it is probable that in a few years all railroads will have the same gauge. The tendency toward narrow gauges has been very conspicuous in the last few years. Starting at 7 ft., the general railway gauge has been reduced successively to 6 ft., 5½, 5, and 4 ft. 8½ in., and now not a few are coming down to 3 ft. 6 in.

Work has been commenced on the Portage, Westbourne & Northwestern Railroad. This road, which connects with the Canadian Pacific at Portage la Prairie, Manitoba, has charters from both the Manitoba and Dominion parliaments. It is intended to run from Portage northwesterly, following generally the route chosen by the government for the Canadian Pacific main line, but which was abandoned on the company taking all the work from the government. The proposed route of this road passes through Gladstone, a town located in the valley of the Little Saskatchewan, crosses the Bird Tail Creek a few miles above Bostle and the Assiniboine, near the mouth of Shell River, thence leading northwesterly for Prince Albert, on the north branch of the Great Saskatchewan 550 miles northwest of Winnipeg, and where there is already a large settlement. The road passes through a country easy for construction, the only really difficult and expensive portions of the work being the crossings of the Little Saskatchewan, Bird Tail Creek, Assiniboine and Great Saskatchewan rivers.

NEW PROJECTS.

Articles of incorporation were filed on the 20th at Springfield by the Belt Line Railroad Company, of Chicago, capital $5,000,000. The line is to run from South Chicago to a point on the Burlington road, in the town of Cicero, thence to Jefferson, thence to the Northwestern track at Lake View, and thence east to the lake.

CONTRACTING, MISCELLANEOUS, ETC.

A large mass-meeting of the taxpayers of Danville, Va., recently adopted a resolution favoring the purchase by the city government of the water power of Dan River at that place. It is proposed to improve the property so as to secure at least 1,000 horse power and to lease it in parcels on liberal terms with a view of making Danville a manufacturing city.

New York State Engineer and Surveyor Seymour opened the proposals for dredging 23,000 cubic yards at Round Shoals, in the Hudson River, between this city and Troy. The following bids were received:

E. M. Payn, per cubic yard	30½ cents.
John M. Sewell, per cubic yard	85 cents.
P. W. Myers, per cubic yard	23 cents.

The contract was awarded to P. W. Myers at 23 cents per cubic yard.

A dispatch from Akron, Ohio, dated July 20, says: "The Akron city council rejected all bids for building the Main street conduit for the mill-race, because all were far above the estimates made on the expense. The cost was considered too great even at the figures made by the lowest bidder. Bids will be advertised for again, and a special effort made to get contractors from out of the city to bid for the work. The council ordered bids advertised in the Chicago *Tribune*. Here is an opportunity for some foreign contractor to get acquainted with the magnitude of Akron's public improvements this year. It looks now as though the Main street improvement had not fallen through and that the old canal must go."